PROJECT TITLE: Web-enabled Modeling and *The National Map*

PRINCIPAL INVESTIGATOR(S):

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DURATION OF PROJECT: 3 years

FY 2004 FUNDING REQUEST: $288,151

STUDY AREA/REGION(S): N/A

RESEARCH THEME(S): modeling

KEY WORDS: (no more than five) *The National Map,* Analytical Modeling, Geospatial Data, Web-Enabled, AGNPS

ABSTRACT: This project will demonstrate the application of *The National Map* to web-enabled modeling by deriving model parameter values from data extracted from *The National Map*, and by recommending modeling tools to be developed for *The National Map*. The project will use the Agricultural Non-Point Source (AGNPS) pollution model as a case study. AGNPS is a cell-based model that uses information derived from land cover, soils, and elevation data.

BACKGROUND: *The National Map* will support two fundamental uses of geospatial information: visual interpretation, and analytical modeling. Visual interpretation typically involves the selection and display of *The National Map*. The area of interest is identified, and the appropriate information is selected, displayed as a map, and simultaneously analyzed and interpreted while the person views the map.

Similarly, analytical modeling involves the selection of *The National Map* content. However, the use of the information is somewhat more complicated. Once the area of interest has been identified and the appropriate information is selected, parametric values must be extracted, possibly reformatted, and inserted into the model. Extracting those values has traditionally required an understanding of the appropriateness of the source and the requirements of the model.

A simple test of the appropriateness of a particular source of information is to extract parametric values from that source, use the extracted values in a model, and evaluate the accuracy of the results. Many natural process models rely on parameters that can be specifically extracted from the elevation component of *The National Map,* the National Elevation Dataset (NED). Slope and aspect are routinely derived from elevation data and used in models to simulate natural process such as surface water runoff. When combined with other parametric values they can be used to estimate the physical characteristics of watersheds, or simulate natural watershed processes such as runoff or erosion rates (Garbrecht and Martz, 2000; Shroder and Bishop, 2003).

The AGNPS pollution model uses derived and other parametric values to simulate watershed processes. It was developed by the USDA Agricultural Research Service to simulate runoff, soil erosion and nutrient transport within agricultural watersheds following storm events. AGNPS is cell-based and uses input parameters extracted or derived from three data sets: land cover, soils, and elevation (Finn and others, 2002). Elevation data are used specifically to determine the extent and morphology of the watershed. Land cover and soils data are used to characterize the surface of the watershed.

Finn and others (2002) demonstrated the utility of geospatial databases as sources of information for the parameterization of models. A logical continuation is to web-enable the process by coupling parameterization with *The National Map*. This project will demonstrate client-side web-enabled modeling with AGNPS by simulation of extracting and deriving elevation and land cover parameters from *The National Map.* This project will also investigate the feasibility of developing server-side modeling tools that could be made available through *The National Map*.

HYPOTHESIS/QUESTION: This investigation will focus on a single research hypothesis: *The National Map* supports the development of a web-enabled modeling environment. This hypothesis will be tested in two ways. First, this project will attempt to extract elevation and land cover parameters for the AGNPS model from *The National Map*. Second, this project will investigate the feasibility of adding modeling tools, such as a user-defined basin delineation application, which uses data available as part of *The National Map*.

APPROACH: This study will take a three-phased approach to identifying and quantifying critical issues associated with developing a web-enabled modeling environment for *The National Map.* The three phases are as follows:

1) Select a model and determine its parameterization protocol,
2) Identify limiting factors to the development of client-side parameterization tools, and
3) Identify limiting factors to the development of server-side parameterization tools.

Phase 1 of this project is well under way. AGNPS was selected due to the experience of the researchers using AGNPS and its protocol for determining parameter values (Finn and others, 2002). The focus will be on those values that are extracted or derived from elevation data. Simulation of the web-based extraction of values from land cover and soils data will be done since this functionality is currently not in place.

Phase 2 will involve an assessment of client-side web-enabled modeling, followed by a proof-of-concept development of a pre-processing capability to AGNPS that extracts the appropriate data from *The National Map*, derives parametric values, and provides those values to AGNPS. A comparison will be made between the values derived by the pre-processor and values determined by a modeler.

Phase 3 will focus on a proof-of-concept development of server-side modeling tools that can be added to *The National Map*. For example, a tool may be recommended that derives a user-defined drainage basin based on *The National Map* elevation data. This tool might enable a user to select a point along a stream or on a hill slope, or provide a positional value in some ground coordinate system. Similar to some non-web-enabled current software packages that generate model parameters, the tool would then delimit the drainage basin that contains that point or positional value (Viger et al., 2002; Usery et al., 2003.) In addition, the tool could also provide parametric values for the point (elevation, slope, aspect), or characteristic measures of the basin (area, perimeter length). The outline of the drainage basin might then be used as a template to extract information from other data sets such as the number or order of streams, or to determine land cover types within the basin.

PRODUCTS: We will produce a series of USGS Open-File reports that provide a theoretical foundation for the project, describe annual progress, and present recommendations regarding *The National Map* modeling tools. We also anticipate articles for publication in refereed journals and presentations at national and international conferences. All of the publications will be available electronically through a project web site.

PROJECT PERSONNEL QUALIFICATIONS:

Jeffrey Spooner

Dr. Spooner will serve as the principal investigator responsible for the coordination of all project activities. He will manage the overall research activity and be responsible for the theoretical and proof-of-concept development of a web-enabled model and the recommendations for modeling tools to be included in *The National Map*. He will also coordinate the production of various reports, papers, and presentations.

Title Geographer
Education B.A. Southern Illinois University - Carbondale, Geology
M.A. University of Missouri - Columbia, Geography
Ph.D. University of Missouri - Rolla, Geology and Geophysics

Research Interest, Relevant Experience and Accomplishments: Dr. Spooner has worked at the Mid-Continent Mapping Center since 1985. Before 1995, his interest focused on the revision of topographic maps. He conducted research into the feasibility of using satellite image data to detect and delineate urban change and as a profiling source for digital elevation models. He also participated in the development and implementation of digital revision and cartographic finishing systems. Since 1995 he has refocused his attention on the development of a geographic research program within NMD. He has written integrated science plans and jointly funded proposals, and has participated on interdisciplinary research teams focused primarily on the Missouri River. In 1998, Jeff helped define the NMD Geographic Research and Applications Program, which evolved into the discipline's Geographic Analysis and Monitoring Program. Throughout his career he has participated on disciplinary, interdisciplinary, and interagency teams, and has completed two details to Reston: to help develop specifications and benchmark tests for the USGS GIS-II procurement, and as Special Assistant to the Director, USGS.

Michael P. Finn

Mr. Finn will coordinate the investigators efforts to demonstrate model parameter derivation from *The National Map* or *The National Map*-like sources and demonstrate a feasible web interface to the current AGNPS Data Generator program. He will manage the provision of all necessary computer programming support and manage any development of unique solutions or one-of-a-kind systems. He will contribute to the on-going professional presentation of research results.

Title IT Specialist
Education B.S. Southwest Missouri State University, Geography
M.S. Virginia Polytechnic Institute & State University, Civil Engineering

Research Interest, Relevant Experience and Accomplishments: Mr. Finn has worked as a Applications Programming IT Specialist with the USGS for four years and has 17 years experience with the US Department of Defense; 10 years with the US Air Force and seven years with the Defense Mapping Agency. His research interests are in quantitative approaches to imaging in environmental modeling and geographic information science; in geodesy and spatial coordinate systems; and in discrete mathematical and scientific applications for digital geospatial data. He has provided computer-programming support for geographic and cartographic research projects, and provided development of one-of-a-kind systems and proof-of-concept systems for this type of research. Mike has been a principal investigator on cartographic research projects dealing with map projections of small-scale raster datasets and with integrating geographic information systems to process models. He has led a team of software engineers designing and developing geospatial applications for mapping sciences research projects and led the MCMC's Programming Support Unit. He is Past President, Central Region, American Society for Photogrammetry and Remote Sensing.

David Shaver

Mr. Shaver will coordinate the investigation's focus on the usefulness of *The National Map* data layers as basic input to physical process models. He will manage, particularly, the viability of any proof-of-concept development from the end-user's perspective to guarantee utility of *The National Map's* geospatial information to analytical modeling. He will contribute to the papers and presentations produced in conjunction with this project.

Title Geographer
Education B.S. Northwest Missouri State University, Geology

Research Interest, Relevant Experience and Accomplishments: Mr. Shaver is the Point of Contact for the Land Cover Trends Project at MCMC. The focus of the Land Cover Trends project is to document within ecoregions, the rates, causes, and consequences of land use and land cover change for the conterminous United States for the 1972-2000 period. This study uses sampling and change analysis techniques combined with Landsat MSS and TM data for measuring land cover change. He is also a GPS and GIS Technical Specialist for the Wildland Firefighting Incident Command System. Before going to work in 1988 with the USGS, he worked for several years for private companies involved in aerial photogrammetry, engineering, and cadastral mapping.

E. Lynn Usery

Dr. Usery will provide expertise on AGNPS modeling and guidance to support the Web-based parameter extraction process. He will work with the other PI's to achieve the modeling interface and help with the development and publication of the project results.

Title Research Geographer
Education B.S. University of Alabama, Geography
M.A. University of Georgia, Geography
Ph.D. University of Georgia, Geography

Research Interest, Relevant Experience and Accomplishments: Dr. Usery conducts research in geographic information science, including geographic information systems, remote sensing and cartography. He has written publications on theoretical aspects of geographic representation, human cognition of geographic phenomena, map and database projections, automatic feature extraction, and visualization, and applications of geographic information science to precision farming, watershed modeling, and water quality. Dr. Usery currently is President-Elect of the University Consortium for Geographic Information Science (UCGIS), Immediate Past-President of the Cartography and Geographic Information Society, and Editor of the journal *Cartography and Geographic Information Science.*

LITERATURE CITED:

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MISCELLANEOUS: N/A

BUDGET: Please refer to the FY '04 project budget outline.

Signed:

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Principal Investigator(s)

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Cost Center Chief

This form should indicate signatures and be forwarded electronically to bmiller@usgs.gov by Cost Center Chief.